PATENT SPECIFICATION 982,806

DRAWINGS ATTACHED.

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982,806

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COMPLETE SPECIFICATION.

Improvements in Multi-Cavity Magnetrons.

We, ASSOCIATED ELECTRICAL INDUSTRIES LIMITED, a British Company having its registered office at 33 Grosvenor Place, London, S.W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to improvements in multi-cavity magnetrons and more particularly to the provision of improved means for coupling such a magnetron to a microwave feeder such as a waveguide or a coaxial line.

In a multi-cavity magnetron, it is common practice to stabilise the magnetron to operate in the π mode by strapping together alternate inter-cavity segments of the magnetron anode block, and this is often done by using two concentric rings each having one end face recessed and the recesses in the two rings being staggered so that one ring joins together alternate inter-cavity segments and the other ring joins together the remaining inter-cavity segments. Each ring may be incomplete in order to increase the stability of the magnetron, in a well-known manner.

The extraction of energy from a multi-cavity magnetron can be effected either by the use of a loop linking with the magnetic field of one of the cavities, or alternatively by a conductor, or conductors, attached to the anode segments. In either case an intermediate connection to the external feeder, for example coaxial line or waveguide, is required.

An object of the present invention is the provision of an improved multi-cavity magnetron suitable for coupling directly to a waveguide or a coaxial line.

According to the present invention, a multi-cavity magnetron is provided at one end of the anode block with concentric cylindrical or frusto-conical members of conductive non-magnetic material separated from one another by an annular space, the inner member being connected at a first end to first strapping means arranged to connect together alternate inter-cavity segments of the anode block and at the second end to a first output connection, and the outer member being connected at the first end to second strapping means arranged to connect together the remaining inter-cavity segments of the anode block and at the second end to the inner edge of an annular pole piece of the magnetron which serves as the second output connection, the output connections being provided with or adapted for the connection thereto of coupling means by which the magnetron anode can be coupled to a microwave feeder.

The invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:—

Figure 1 is a longitudinal cross-section through a magnetron coupled to a waveguide; and

Figure 2 is a longitudinal cross-section of the output end of a similar magnetron coupled to a coaxial line.

Referring first to Figure 1, the magnetron 1 comprises a cylindrical cathode 3 arranged to extend axially through a cylindrical bore 5 in the copper anode block 7, which is formed in conventional manner with a circle of cylindrical cavities 9 the axes of which are parallel to that of the bore 5 and each of which communicates with that bore through a narrow slot. These slots divide the periphery of the bore into inter-cavity segments 11. Alternate segments 11 are connected together by a ring-like strap 13,

the side of which nearer the anode block is cut-away or recessed so that the strap misses the remaining segments. The remaining segments 11 are connected together by a second ring-like strap 15, concentric with but larger in diameter than strap 13, and similarly recessed on the side nearer the anode block. The construction so far described is conventional.

Parallel to but spaced from the end face of the anode block 7 is an annular pole piece 17, the central aperture 17A of which is coaxial with the bore 5. The outer strap 15 is connected to the pole piece 17 by a frusto-conical conductive member 19 formed out of non-magnetic metal such as copper, member 19 being secured to the periphery of the aperture 17A at the side of the pole piece nearer the anode block 7. A similar but smaller frusto-conical conductive member 21 is connected at its larger end to the inner strap 13 and is disposed inside and coaxial with the member 19, so that the two members are separated by an annular space 23. At its smaller end member 21 is secured to a circular pole piece 25 arranged coplanar with the annular pole piece 17 and arranged coaxially in the aperture 17A so as to leave free a continuation of the annular space 23.

The magnetron is mounted on a waveguide 27 of rectangular cross-section by a metal distance piece 29 of circular transverse cross-section and provided at each end with flanges which are secured respectively to the annular pole piece 17 and to the waveguide wall. A rod-like copper probe 31, secured at one end to the circular pole piece 25, extends through an aperture 33 in the waveguide wall and is protected by a dome 35, of suitable dielectric material, mounted on the distance piece 29.

Four metal rods 41 are mounted on the outer member 19 and extend inwardly across the space 23 and extend with an annular clearance through holes 42 in the member 21 into the space above the cathode 3.

In use of the magnetron, the magentron anode is effectively coupled through the members 19 and 21 and the probe 31 to the waveguide 27. The rods 41 serve to neutralise capacitive coupling between the cathode 3 and the inner member 21.

It is found that, with the improved output arrangement shown, the novel connection between the output probe 31 and the anode block 7 provides a tighter coupling than do conventional arrangements, and also has a lower inductance.

If desired, apertures may be provided in the inner member 21 and/or in the outer member 19 to influence the wavelengths of the resonant modes of the magnetron.

The magnetron is sealed as a component and a glass window provides the vacuum seal in the vicinity of the output probe.

In the case of a magnetron in which the pole pieces at each end of the anode are only a relatively short distance apart, an inner pole piece 25 is required to produce a uniform magnetic field in the reaction zone. However, in the case of a magnetron where the pole pieces are further apart, a substantially uniform magnetic field can be obtained even with a central aperture in the pole pieces.

Figure 2 shows the output end of a magnetron, having output connections from the anode to the pole-piece as already described, coupled to a coaxial line. Below the pole-piece 17 the construction of the magnetron is similar to that shown in Figure 1, except that in this particular case only two rods 41 have been provided on the inner surface of the conical conductor 19. Instead of having the distance piece 29, the probe 31 and the dome 35, as shown in Figure 1, the magnetron when adapted for attachment to a coaxial line is fitted with a metallic cylindrical tube 43, preferably non-magnetic, terminated by a pinch-seal 45, coaxial with the pole-piece 25 and extending from it away from the magnetron body, and coaxial with the tube 43 a frusto-conical/cylindrical bell-shaped member 47 consisting of upper 49 and lower 51 metallic portions joined by a cylindrical glass portion 53. The lower end of the tube 43 is secured (preferably with a hermetic seal) to the outer circumference of the inner pole-piece 25. The lower edge of the bell-shaped member 47 is hermetically sealed to the outer circumference of the main pole-piece 17. The upper metallic portion 49 of the bell-shaped member 47 is formed with a flange 55 which is hermetically sealed to the upper end of the tube 43. The tube 43 is provided with one or more holes 57 through which, and through the annular space 17A in the pole-piece 17, the tube is in communication with the magnetron body. The magnetron is evacuated *via* the tube 43 which is then closed by the pinch-seal 45.

The coaxial line to which the magnetron is coupled comprises inner 59 and outer 61 concentric metallic tubes, coaxal with the magnetron end of diameters substantially equal respectively to those of the cylindrical tube 43 and the outer wall of the magnetron body 1. The magnetron is secured to the coaxial line by welding of the inner conductor 59 to the flange 55 and by soldering of the outer conductor 61 to the body 1.

In operation, electromagnetic energy from the magnetron passes upwards through the annular gap 19A and through the cylindrical window 53 into the coaxial line.

WHAT WE CLAIM IS:—

1. A multicavity magnetron, provided at one end of the anode block with concen-

tric cylindrical or frusto-conical members of conductive non-magnetic material separated from one another by an annular space, the inner member being connected at a first end to first strapping means arranged to connect together alternate inter-cavity segments of the anode block and at the second end to a first output connection, and the outer member being connected at the first end to second strapping means arranged to connect together the remaining inter-cavity segments of the anode block and at the second end to the inner edge of an annular pole piece of the magnetron which serves as the second output connection, the output connections being provided with or adapted for the connection thereto of coupling means by which the magnetron anode can be coupled to a microwave feeder.

2. A multi-cavity magnetron as claimed in Claim 1, wherein the second end of the inner member is connected to the outer edge of a cylindrical pole piece, co-planar and coaxial with the annular pole piece, there being an annular gap between the two pole pieces, and the cylindrical pole piece serves as the first output connection.

3. A multi-cavity magnetron as claimed in Claim 1 or Claim 2, wherein apertures are provided in the outer member and/or the inner member, whereby the wavelengths of the resonant modes of the magnetron are influenced.

4. A multi-cavity magnetron as claimed in any preceding claim, wherein conducting rods or pegs extend inwardly from the outer member with annular clearance through apertures in the inner member, whereby capacitive coupling between the cathode and the inner member is neutralised.

5. A multi-cavity magnetron as claimed in any preceding claim, wherein the first and second strapping means each comprises an incomplete ring.

6. A multi-cavity magnetron as claimed in any preceding claim, wherein the coupling means comprise means for connecting the annular pole piece to the wall of a waveguide and means for radiating electromagnetic energy into the waveguide through an aperture in the wall.

7. A multi-cavity magnetron as claimed in Claim 6, wherein a coupling probe is connected to the first output connection.

8. A multi-cavity magnetron as claimed in Claim 7, wherein the coupling probe comprises a cylinder of conducting material projecting away from the magnetron cathode and protected by a cap of suitable insulating material mounted on a member of the magnetron body.

9. A multi-cavity magnetron as claimed in any of Claims 6 to 8, adapted for connecting to a rectangular waveguide by means of a cylindrical metal distance piece attached to the outer side of the annular pole piece and having a cap of insulating material mounted on it.

10. A multi-cavity magnetron as claimed in any of Claims 1 to 5, wherein the output coupling means comprise means for connecting the annular pole piece to the outer conductor of a coaxial line and means for guiding electromagnetic energy from the magnetron into the space between the outer and inner conductors of the coaxial line.

11. A multi-cavity magnetron as claimed in Claim 10, wherein a tube of conducting material is connected to the first output connection, the tube being coaxial with the magnetron and extending away from the anode to a point suitable for the sealing thereto of the inner conductor of the coaxial line, and a bell-shaped member coaxial with the tube and comprising end sections of conducting material joined by an intermediate window of suitable insulating material is hermetically sealed at its narrower end to the outer end of the tube and at its wider end to the magnetron body, whereby electromagnetic energy from the magnetron can pass through the window into the space between the inner and outer conductors of the coaxial line when such a line is connected to the magnetron.

12. A multi-cavity magnetron as claimed in Claim 11, wherein the tube is provided with an opening or openings whereby its interior is in communication with the magnetron body through the annular space between the inner and outer members.

13. A multi-cavity magnetron as claimed in Claim 12, wherein the magnetron is evacuated by means of the tube which is subsequently hermetically sealed at its outer end.

14. A multi-cavity magnetron as claimed in any of Claims 11 to 13, wherein the tube is hermetically sealed to the first output connection.

15. A multi-cavity magnetron construction substantially as shown in, and adapted to operate substantially as hereinbefore described with reference to, Figure 1 of the accompanying drawings.

16. A multi-cavity magnetron constructed substantially as shown in, and adapted to operate substantially as hereinbefore described with reference to, Figure 2 of the accompanying drawings.

17. A microwave transmission system, including the combination of a microwave feeder and a magnetron according to any preceding claim.

18. A microwave transmission system, including the combination of a waveguide

and a magnetron according to any of the claims 6 to 9 and 15.

19. A microwave system, including the combination of a coaxial line and a magnetron according to any of claims 10 to 14 and 16.

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2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 1 & 2

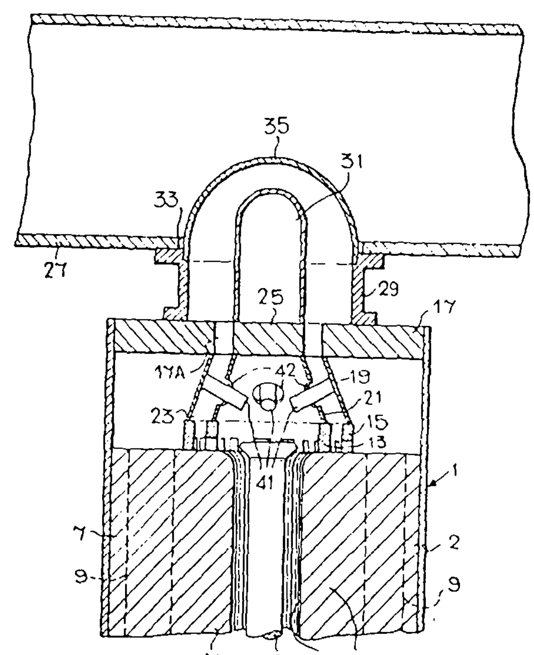

Fig.1.

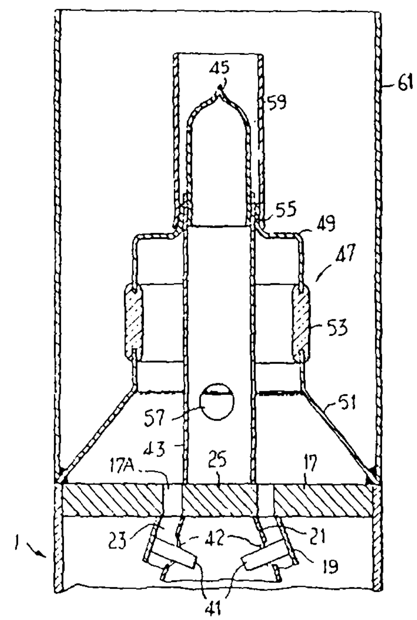

Fig.2.